AN OVERVIEW OF PRODUCTION AND VALIDATION OF THE SMAP PASSIVE SOIL MOISTURE PRODUCT

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1. INTRODUCTION

The Soil Moisture Active Passive (SMAP) mission is an L-band mission scheduled for launch in Jan 2015. The SMAP instruments consist of a radar and a radiometer to obtain complementary information from space for soil moisture and freeze/thaw state research and applications. By utilizing novel designs in antenna construction, retrieval algorithms, and acquisition hardware, SMAP provides a capability for global mapping of soil moisture and freeze/thaw state with unprecedented accuracy, resolution, and coverage. This improvement in hydrosphere state measurement is expected to advance our understanding of the processes that link the terrestrial water, energy and carbon cycles, improve our capability in flood prediction and drought monitoring, and enhance our skills in weather and climate forecast [1].

For swath-based soil moisture measurement, SMAP generates three operational geophysical data products: (1) the radiometer-only soil moisture product (L2_SM_P) posted at 36-km resolution [2], (2) the radar-only soil moisture product (L2_SM_A) posted at 3-km resolution, and (3) the radar-radiometer combined soil moisture product (L2_SM_AP) posted at 9-km resolution. Each product draws on the strengths of the underlying sensor(s) and plays a unique role in hydroclimatological and hydrometeorological applications. A full suite of SMAP data products is given in Table 1.

Table 1. SMAP Data Products

Product	Description	Gridding (Resolution)	Latency**	
L1A_Radiometer	Radiometer Data in Time-Order	-	12 hrs	Instrument Data
L1A_Radar	Radar Data in Time-Order	-	12 hrs	
L1B_TB	Radiometer T_B in Time-Order	(36x47 km)	12 hrs	
L1B_S0_LoRes	Low Resolution Radar σ_o in Time-Order	(5x30 km)	12 hrs	
L1C_S0_HiRes	High Resolution Radar σ_o in Half-Orbits	1 km (1-3 km)	12 hrs	
L1C_TB	Radiometer T_B in Half-Orbits	36 km	12 hrs	
L2_SM_A	Soil Moisture (Radar)	3 km	24 hrs	Science Data (Half-Orbit)
L2_SM_P	Soil Moisture (Radiometer)	36 km	24 hrs	
L2_SM_AP	Soil Moisture (Radar + Radiometer)	9 km	24 hrs	
L3_FT_A	Freeze/Thaw State (Radar)	3 km	50 hrs	Science Data (Daily Composite)
L3_SM_A	Soil Moisture (Radar)	3 km	50 hrs	
L3_SM_P	Soil Moisture (Radiometer)	36 km	50 hrs	
L3_SM_AP	Soil Moisture (Radar + Radiometer)	9 km	50 hrs	
L4_SM	Soil Moisture (Surface and Root Zone)	9 km	7 days	Science Value-Added
L4_C	Carbon Net Ecosystem Exchange (NEE)	9 km	14 days	

2. PRODUCTION OF PASSIVE SOIL MOISTURE PRODUCT

In this presentation, the production and validation processes of the SMAP radiometer-only soil moisture product will be described. The production of the product begins with the mapping of the Level 1 time-ordered brightness temperature (TB) observations on an Earth-fixed grid [3]. The gridded TBs are then used as the primary input to the SMAP L2_SM_P soil moisture retrieval algorithm. Besides TBs, a variety of static ancillary data (e.g. water fraction, soil texture, land cover classification, vegetation index climatology) and dynamic ancillary data (e.g. near real-time soil temperature, freeze/thaw state, rainfall intensity) are also ingested. These ancillary datasets provide information to facilitate geophysical inversion and data flagging that indicates anomalous issues that may affect product accuracy and usability. Figure 1 summarizes the overall processing workflow of the L2_SM_P Science Production Software (SPS). A new approach will also be presented to describe how post-launch model calibration will be performed globally with operation SMAP data and ancillary data.

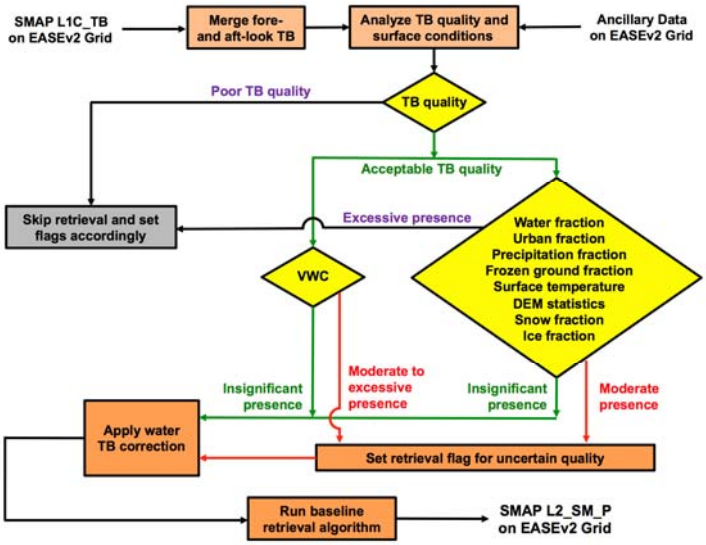

Figure 1. L2_SM_P SPS Algorithm Flowchart

3. VALIDATION OF PASSIVE SOIL MOISTURE PRODUCT

On the validation aspect, the accuracy of the preliminary product will be evaluated using *in situ* data, sparse networks, and other satellite data products. Figure 2 illustrates the comparison between the *in situ* data and soil moisture estimates using the SMAP L2_SM_P soil moisture retrieval algorithm with SMOS 40° brightness temperatures as surrogate input data for June 2013—July 2014. As evident in the figure, the soil moisture estimates and *in situ* data were in good agreement, with an accuracy (0.034 cm^3/cm^3) exceeding the mission target accuracy of 0.040 cm^3/cm^3. Figure 3 explores the relative merits among the baseline and option algorithms retrieval algorithms implemented by SMAP. Although all algorithms properly captured the overall variability of

the *in situ* observations, they did so with various degrees of accuracy and temporal characteristics. After launch, similar analyses but over a wider range of land surface conditions will be conducted with real SMAP data.

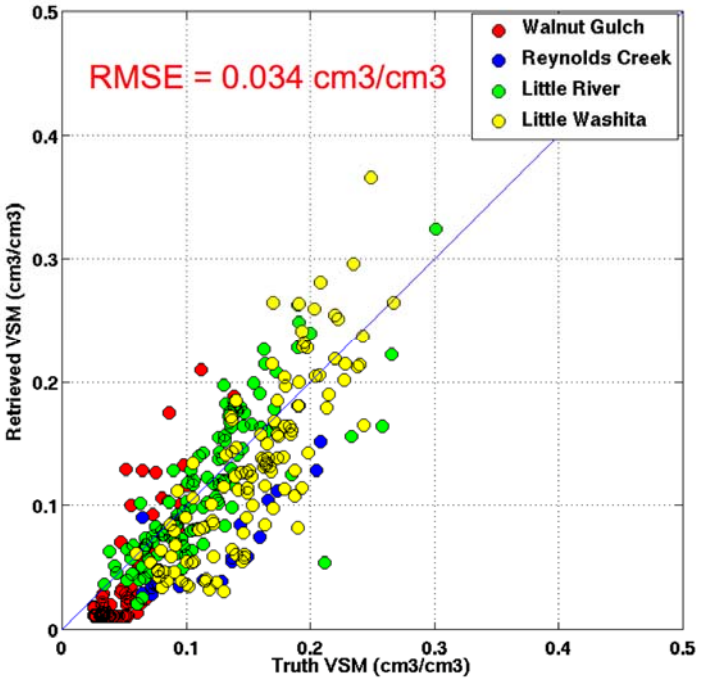

Figure 2. Comparison of the simulated L2_SM_P (derived from SMOS 40° brightness temperatures) with *in situ* data from USDA ARS watershed core validation sites. The same exercise will be conducted after launch with real SMAP data to confirm the performance of L2_SM_P.

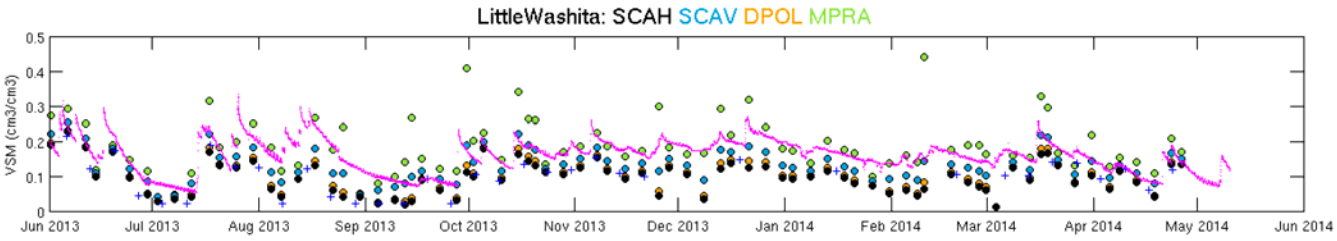

Figure 3. Comparison of simulated L2_SM_P (derived from SMOS 40° brightness temperatures) with *in situ* data (magenta) and Aquarius soil moisture product (cross). Baseline (SCAH) and option algorithms (SCAV, DPOL, and MPRA) were evaluated. The same exercise will be conducted after launch with real SMAP data to confirm the performance of L2_SM_P.

4. CONCLUSION

This presentation describes the production and validation processes of the SMAP radiometer-only soil moisture product. The results are based on an early version of the SMAP data. It is expected that with a properly calibrated forward model and a comparison scheme that properly accounts for the differences in spatial scales

between satellite data and *in situ* data, the SMAP radiometer-only soil moisture product can be shown to meet the mission accuracy requirement of 0.04 cm^3/cm^3.

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